Explaining variability in surgical decision-making:

Developing qualitative and quantitative models to characterize surgeons' choice of treatments

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Abstract: Surgeons commonly face situations in which they must be ready to make a decision. Their expertise and capability, both obtained by surgical training and experience, as well as guidelines, guide them in the decision making process. Nevertheless, evidence reported in the literature points out for a large and unexplained variability in surgical decision making, even in areas in which scientific evidence exist. In some contexts, such as for the treatment of acute cholecystitis, there is a lack of evidence and tools to assist doctors in their decisions.

This thesis develops and applies multicriteria methods to explore how surgeons make decisions concerning the treatment of acute cholecystitis patients, as well as constructs a decision support model to assist surgeons in the choice of treatment. A multimethodology based on the MACBETH approach is built to meet those objectives. It starts by using exploratory interviews to understand and structure the multiple factors that surgeons consider in the evaluation of patients and in treatments' choice. Then, making use of a web-based platform that makes MACBETH based questions, it is constructed an individual model that captures the views of each one of ten surgeons from Hospital de Santa Maria in Lisbon. Then all surgeons are set to participate in a decision conference and a MACBETH group model is built.

With the application of this multimethodology, we could explore the variability across surgeons' views, the convergence towards a group model and, based on the group model, to build a decision support model to assist them in future surgical decisions. Results shows that, despite giving different qualitative judgments, most of surgeons end up evaluating the patient state in a similar way, which generates similar results in the different models; regarding the decision support model, there was agreement by the surgeons, however, work needs to be done to have the information that the model needs to evaluate the patient state according to each way of treatment.

Keywords: Surgical Decision Making; Variability; Acute Cholecystitis; Decision Support Model; MACBETH.

1. Introduction

Surgeons must be always prepared to make a decision. They acquire expertise not only with the training and experience but also consulting guidelines and available scientific data on the matters. This expertise guide them in the decision making process.

To make a decision, there are four strategies mostly followed by the surgeons: intuitive, rule-based, analytical and creative. Intuitive is when the answer is immediate, being this capacity improved with the surgeon experience; rule-based happens when a standard procedure is followed, often used by the novices; analytical is when there are several options remembered and the doctor decides what he thinks that is the best to the situation and creative strategy occurs when the doctor creates a solution. Intuitive and rule-based strategies are the most used in surgical decision making [1].

Nevertheless, despite the known strategies of thinking and the access doctors have to the more recent scientific evidence, there is a lot of unexplained variability in surgical decision making, even when there is scientific data on the subject. Variability occurs when similar patients receive different treatments depending on the doctor, the demographic region or the period of time they are treated but it is defined as unwanted when it is not explained by patients' preferences [2].

Variability is more frequent in preference-sensitive care procedures, the ones that imply significant trade-offs to the patient affecting his quality and length of life, and it occurs either by the doctor beliefs about the effectiveness of the procedures or by how the doctor includes the patient preferences [3][4].

In the surgery field, it has been proved that surgeons' opinions influence a lot the decision making process: 70% of the times surgeons choose a treatment according to their preferences instead of looking to the circumstances [5]. Thus, with this work it is intended to observe how surgeons evaluate their patients' state, which is the basic information to the choice of a treatment once these choice is always based in what would bring more benefit to the patient, i.e., what would provide a better state.

Variability in surgical decision making as a consequence of the different surgeons' opinions will be explored, using a specific disease, acute cholecystitis, to illustrate how surgeons make decisions concerning its treatment. Moreover, a decision support model will be built to aid in this decision.

2. Literature Review

Acute cholecystitis is an inflammation of the gallbladder and it occurs 95% of times due to gallstones that obstruct the cystic duct causing a bacterial or chemical inflammation [6][7]. When associated with gallstones it is named acute calculous cholecystitis (ACC) and when it is not it's named as acalculous (AAC) and occurs more abruptly [8]. Females have more risk of having acute cholecystitis as well as older people, pregnant women, obese and diabetic people [9].

The surgical removal of the gallbladder, cholecystectomy, is the preferred treatment for these cases [6]. However, there is controversy worldwide about the perfect timing to do it when patients go to the hospital with more than 72 hours after the onset of symptoms: if as soon as possible when the patient is admitted in the hospital (ELC – early laparoscopic cholecystectomy) or only after a conservative treatment, in which the patient receives antibiotic therapy, getting the surgery in other hospital scheduled admission (ILC – interval laparoscopic cholecystectomy). Both ways present pros and cons, while ELC is performed when the tissues are inflamed which brings more difficulties to the surgery, ILC has a waiting time (the conservative treatment time) in which sometimes complications occur leading to urgent surgeries, even worst to deal with.

The choice of treatment intends to leave the patient in the better possible state and the evaluation of patient state depends on several dimensions. In line with this, multicriteria decision analysis (MCDA) and its application in healthcare is also explored in this review.

G. Adunlin *et al.* in 2014 revealed the growth of MCDA in healthcare, when conducting a systematic review and bibliometric analysis about its application in this area [10]. The most used technique recognized in this review was Analytic Hierarchy Process however, it has been criticised by several studies for authors as C. Bana e Costa and J. C. Vansnick [11]. Thus, MACBETH (Measuring Attractiveness by a Categorical Based Evaluation Technique) approach is explored here. This approach allows building a quantitative model based on qualitative judgements of difference of attractiveness [12], which is considered an advantage because expressing the preference judgments numerically is considered cognitively uneasy [13].

MACBETH approach was already used in several studies in the healthcare context in matters such as hospital auditing [13], prioritization of community care programmes [14], evaluation of health and safety risks [15], planning of decisions in long-term care [16] or assisting in the diagnosis of Alzheimer's disease [17]. However, concerning the choice of a treatment, examples were not found to report.

The methodology to explore the variability in surgeons' opinions concerning the treatment of acute cholecystitis patients, as well as to build a decision support model to assist surgeons in the choice of treatment is presented next.

3. Methodology

To meet the mentioned objectives a multimethodology composed by different techniques that complement themselves was built and it is presented in figure 1. It follows a socio-technical approach. The advantages of this approach, according to L. Philips and C. Bana e Costa, are that it [18]: "(…) improves communication (…), develops shared understanding (…) and generates a sense of common purpose (…)", very important goals to reach specially in the compromise model phase, once this phase produces the decision

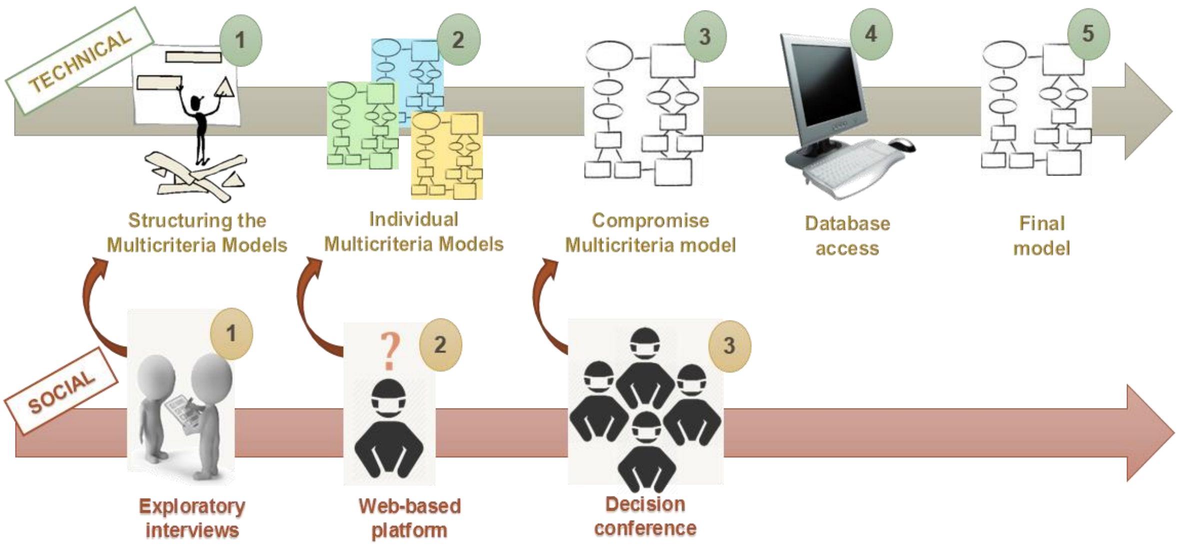


Figure 1. Social and technical components of socio-technical approach that describes the multimethodology. The numbers indicate the sequential order of the steps.

support model for the hospital, which must be accepted by all the members of the group.

The multimethodology starts by using exploratory interviews to understand and structure the multiple factors that surgeons consider in the evaluation of patients and in the choice of treatments. Then, making use of a web-based platform that makes MACBETH based questions, it is constructed an individual multicriteria model that captures the views of surgeon. All surgeons are then set to participate in a decision conference and a MACBETH group model is built. Before describing the steps, the MACBETH approach is explained.

3.1. MACBETH Approach

The MACBETH approach main advantage is that it only needs "qualitative judgments about the difference of attractiveness" when comparing two elements in a set, at a time, being the judgments (about the difference of attractiveness) chosen from a given scale: no, very weak, weak, moderate, strong, very strong, extreme. It is a non-numerical method and it originates numerical scores from the qualitative judgments of the decision maker(s), which allows the creation of a value scale per criterion and determine weights for the criteria. For each option (of treatment in this case), the value score on each criterion multiplied by the criterion's weight are aggregated additively to all the criteria giving rise to the overall score of the option, translating its attractiveness [19]. In other words, the overall score V(p) of an option p considering n criteria is obtained by aggregating the partial values v_j(p) of each option p in the criterion j (j=1, …, n), as follows [20]:

$$V(p) = \sum_{j=1}^{n} k_j . v_j(p) \ with \sum_{j=1}^{n} k_j = 1 \ ; \ k_j > 0 \ ; \ \begin{cases} v_j(good_j) = 100 \\ v_j(neutral_j) = 0 \end{cases} \quad (1)$$

being k_j the weight assigned to criterion j.

To develop a multicriteria model, first it is needed to structure the model: define criteria and a descriptor of performance to each criterion, turning it intelligible. The descriptor of performance is constituted by a set of levels, ordered by preference, that measure how a criterion is satisfied by an option. Two of the levels are assigned with the 0 and 100 values and are defined as the neutral and good anchors, respectively. Then value scales are obtained to each criterion and the criteria weights are determined comparing the neutral to good improvements in all the criteria. For the development of the models, it will be used the M-MACBETH software [19].

3.2. Structuring the Multicriteria Models

To obtain relevant information for the definition of criteria and descriptors of performance exploratory interviews were made, individually, to ten surgeons.

The interviews should let each surgeon comfortable in talking about the issues of the decision, however, it must be accomplished the goal of obtaining the needed information. For that, some topics were always asked:

- What options do you have to treat the patient?
- What do you expect to reach when you make a choice of treatment? What is the goal of the treatment, if you could explain it in one sentence?
- Now, suppose that you chose an option of treatment. How can you evaluate the result? What are the factors that differentiate how successful was the intervention?
- *To each factor:*

- Can this factor be subdivided in more components? Which ones?
- Can some of them be grouped?
- If two patients have the same behaviour in these factors, is there another factor to differentiate the patients' result?

These topics and subtopics intended to explore the criteria, mainly the last two topics. Having the answers, the data was treated with the support of Professor Mendes de Almeida, to complete the structuring of the models. The value tree with the criteria is in figure 2 and the descriptors of performance and its levels in table 1.

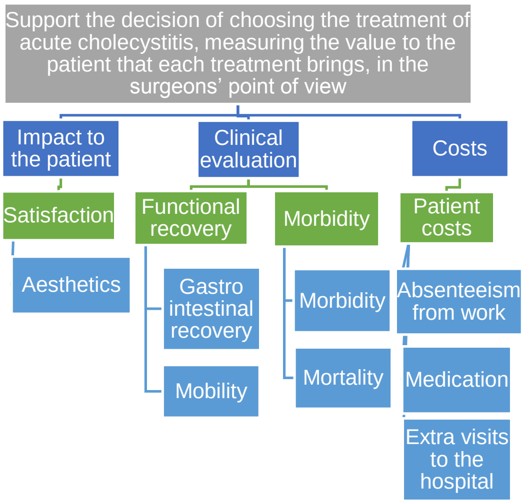


Figure 2. Value tree with the criteria of the decision in the green boxes.

3.3. Individual Multicriteria Models

The development of the individual models consists in building value scales and obtaining criteria weights, for each surgeon, which depends on collecting some specific judgments of the surgeons about differences of attractiveness (according to the MACBETH scale) between some of the performance levels obtained previously. In this case, the judgments asked were about the comparison between each performance level and the least attractive one and between each consecutive pair of performance levels to build the value scales and only the first mentioned comparisons to define the criteria weights. To collect these individual judgments, a web-based platform with MACBETH based questions was implemented.

In the first part of the platform the judgments about differences of attractiveness within each criterion were asked to obtain the value scales for the criteria. For a criterion, the performance levels were presented and each surgeon evaluated the difference of attractiveness (using MACBETH scale) between the mentioned levels, bearing in mind the patient quality of life. Then, questions about the overall attractiveness allowed to define the criteria weights: with all the levels in the neutral level, surgeons were asked to rank the improvements to the good level by attractiveness, giving, once again, their classification according to MACBETH scale.

After collecting the answers, the data was inserted in M-MACBETH software, adopting suggestions of the software when inconsistencies occurred, and the individual models were developed. Then, it was possible the development of the group model.

3.4. Compromise Multicriteria Model

This phase intended to collect the judgements respecting the same comparisons of the individual models, but with the group opinion. To obtain the needed opinions of the group, a decision conference was made. It would allow to discuss the problems, solve inconsistencies, validate each step and build the model on-the-spot.

In the decision conference, first, surgeons were also asked about the differences of

Table 1. Descriptors of performance levels for each criterion.

Criteria	**Descriptors of Performance Levels**
Morbidity	Long-term morbidities classified according to Clavien-Dindo scale [21]. ▪ No morbidity; ▪ Grade I (therapeutic necessity such: antiemetic, antipyretics, analgesics, diuretics and electrolytes) **- GOOD**; ▪ Grade II (other pharmacological therapeutic as antibiotics, parenteral nutrition) **– NEUTRAL**; ▪ Grade III (Requiring surgical, endoscopic or radiological intervention, with or without anesthesia); ▪ Grade IV (simple or multi organ dysfunction); ▪ Grade V (Death).
Functional Recovery	Symptoms presented by the patient. ▪ Asymptomatic; ▪ Reposition of the state previous to the acute episode **- GOOD**; ▪ Minimal symptoms **- NEUTRAL**; ▪ Limitative symptoms; ▪ Incapacitate symptoms.
Satisfaction of the patient	Satisfaction of the patient, considering the aesthetic results of the treatment. ▪ Very satisfied; ▪ Satisfied **- GOOD**; ▪ Not unsatisfied or satisfied **- NEUTRAL**; ▪ Unsatisfied; ▪ Very unsatisfied.
Patient Costs	Costs to the patient. ▪ Without costs and without alteration of the economic balance; ▪ With medication costs. Without extra hospital visits costs and without alteration of the economic balance **- GOOD**; ▪ With extra hospital visits costs. Without medication costs and without alteration of the economic balance; ▪ With medication costs and extra hospital visits costs. Without alteration of the economic balance **- NEUTRAL**; ▪ Without costs but with alteration of the economic balance; ▪ With medication costs and with alteration of the economic balance. Without extra hospital visits costs; ▪ With extra hospital visits costs and with alteration of the economic balance. Without medication costs; ▪ With medication costs, extra hospital visits costs and alteration of the economic balance;

attractiveness within the criteria and after the questions concerning a criterion, the value scale obtained was presented and validated by the group, sometimes after some adjustments. After all the questions and validations about the criteria, the questions about the overall attractiveness started. Once again surgeons were asked to rank the improvements of the neutral to the good level of all the criteria, giving its classification according to MACBETH scale. The criteria weights obtained with these questions were also validated by the surgeons. The model was created on-the-spot, inserting the judgments in the software as surgeons answered. An example of a value scale obtained for the Functional Recovery criterion and the criteria weights can be seen in figure 3.

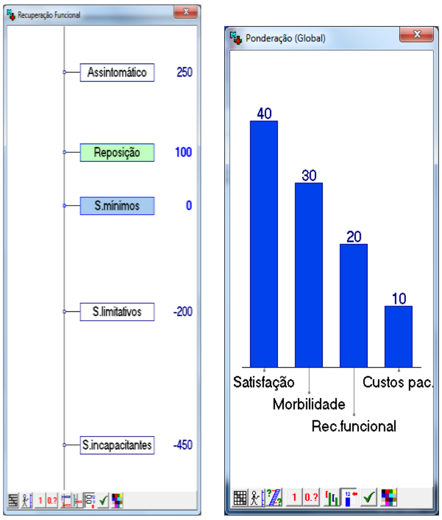


Figure 3. Example of the group value scale to Functional Recovery and the group weights (the ranked obtained was: Satisfaction, Morbidity, Functional Recovery and Patient Costs).

After obtaining the compromise model it could be adapted to a decision support model for the treatment choice of acute cholecystitis. So, the hospital database could be accessed to see how the model would evaluate patients and if possible be improved, resulting in a final model.

4. Results

The results of the multimethodology are presented in this section. First, comparisons are made between the individual and group models to explore the variability in their opinions and the convergence towards the group opinion. Then, using patient cases, the use of the models is illustrated and it is exposed how the group model can be a useful decision support tool, assisting the doctors in their resolutions.

4.1. Comparing the Individual and Group Models

Comparisons are made between all the individual models and with the group model. The differences of attractiveness asked according to MACBETH scale are compared as well as the correspondent value scales. The standard deviation of the values attributed to each performance level is showed in figure 4. Patient Satisfaction criterion is the one with more agreement, having lower standard deviation values, and Morbidity the one with less. Morbidity criterion presents the higher standard deviation in the last performance level (death state) because the value of death in the value scale goes from -225 to -1400 in the individual models, having an average of -468.

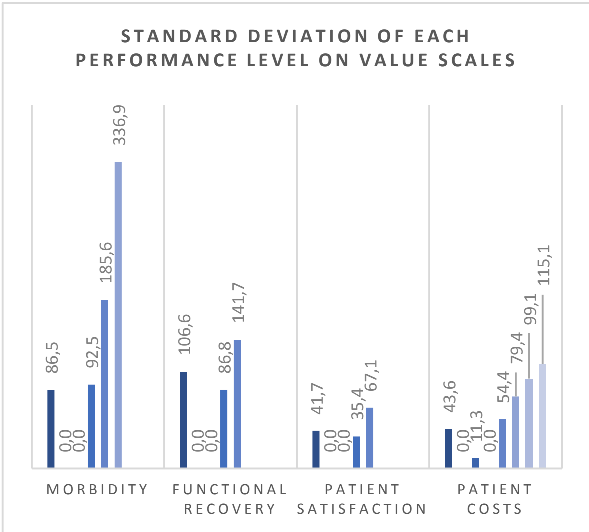
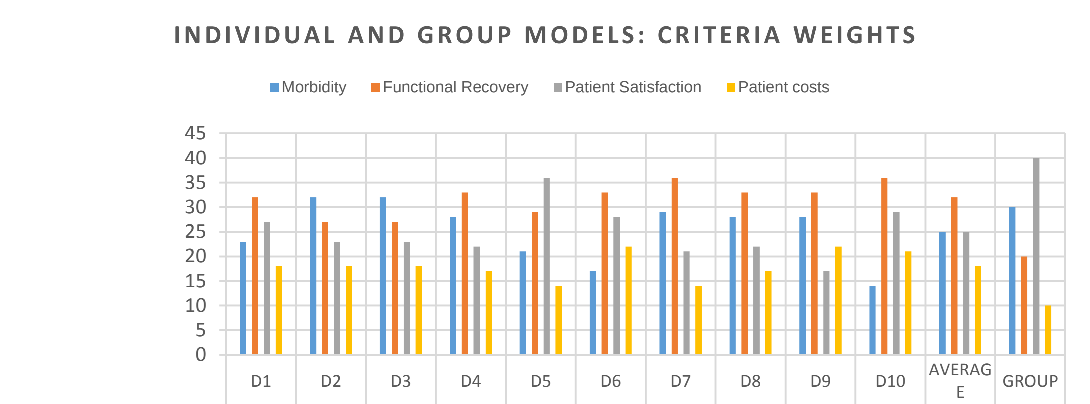


Figure 4. Standard deviation of the performance levels of each criterion in the individual opinions. The zeros are the anchors (neutral and good levels).

Considering the averages of the values of each level, the group values are always in the interval given by the average adding or subtracting the standard deviation, except in the case that the standard deviation is 11.3 in the Patient Costs criterion. Here, the group judgment is outside of the interval however it is by less than four units. Thus, respecting the value scales, it was observed similarity in the individual opinions comparing the attractiveness of improvements and there are not values in group value scales that diverge a lot from the individual ones.



	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	AVERAGE	GROUP
Morbidity	23	32	32	28	21	17	29	28	28	14	25	30
Functional Recovery	32	27	27	33	29	33	36	33	33	36	32	20
Patient Satisfaction	27	23	23	22	36	28	21	22	17	29	25	40
Patient costs	18	18	18	17	14	22	14	17	22	21	18	10

Figure 5. Criteria weights and ranking according to individual opinions and to the group opinion.

The criteria weights obtained according to each surgeon and the group were also compared. Figure 5 presents the criteria weights and, consequently, the ranking according to surgeons, individually and in group.

In the decision conference it was perceptible that the surgeons were ranking the options not considering the neutral to good improvement but they were looking just at the criterion, thinking about what is the more important instead of the improvement they wanted to do first. This reveals how important is involving the decision makers in the development of the multicriteria model and how the on-the-spot development brought advantages. After understanding that they had to rank the improvements and not the criteria, surgeons changed the ranking easily, leading to a first option so different of the individual models. Despite this difference, Patient Costs is ranked in 4^{th} place 70% of the times in individual models and also in the group model.

4.2. The Models Illustrated by Patient Cases

Patient cases were constructed accessing the hospital database. However, the information about the impact of both ways of treatment, ELC and ILC, according to the criteria of the model was not available. First, because if a patient undergoes an ELC, the impact about an ILC could not be documented and second because, even for the chosen approach, the needed information was not documented in the database.

To overcome this difficulty, patients with similar medical history were grouped and two groups were chosen to be surveyed by telephone about the needed information: the patients with no clinical history and the patients with diabetes mellitus type II (DMII). DMII cases were chosen for having an increased risk of complications [22]. In these groups there were patients that underwent both ways of treatment so two general patients were created representing those groups: Patient A – a patient with no clinical history, and Patient B – a patient with DMII. The more recurrent impacts of each way of treatment in both patients, presented in table 2, were selected to insert in the model and observe its evaluations.

Table 2. Patient A and B performances in ELC and ILC according to the answers obtained by the patients.

Criteria		Patient A	Patient B
ELC	**Morbidity**	No morbidity	No morbidity
	Functional Recovery	Asymptomatic	Asymptomatic
	Satisfaction	Satisfied	Satisfied
	Patient Costs	With extra hospital visits costs and with alteration of the economic balance.	With medication costs, extra hospital visits costs and alteration of the economic balance.
ILC	**Morbidity**	No morbidity	No morbidity
	Functional Recovery	Limitative Symptoms	Minimal Symptoms
	Satisfaction	Very Satisfied	Very Satisfied
	Patient Costs	With extra hospital visits costs.	Without costs but with alteration of the economic balance.

These cases allow to observe the answer of the model for those patients and to compare it with the answers of the individual models, however, the cases are very wide-ranging and they must be improved inserting other co-morbidities and other relevant characteristics that influence the result of the treatment.

Both patients have the same performance on Morbidity so, for the two approaches they are evaluated with the maximum partial score on this criterion. The other criteria have pros and cons on each treatment option for both patients. The answers of the models are presented in figure 6 and present a similar evaluation despite some different opinions in the judgments of surgeons.

Figure 6 also presents an overall thermometer given by M-MACBETH software that shows the evaluation of the state of patient A after both treatment options, according to the compromise model.

Regarding the compromise model, the overall scores according to each treatment option are presented and looking at them we can say that ELC is expected to bring more benefit to the quality of life of patient A. This is the way that this model intends to be a decision support model for the hospital: it informs surgeons about what is considered better for each patient according to the surgeons' notions of importance, attractiveness and requirements. The patient cases must be as accurate as possible to insert in the model since each difference can induce a different outcome.

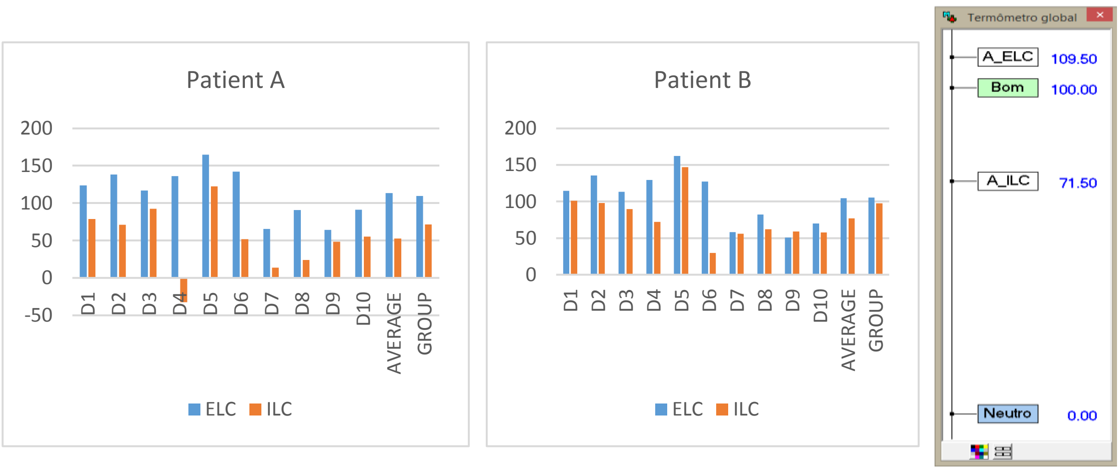


Figure 6. Evaluation of the multicriteria models for patient A at left and patient B in centre. At right, overall scores for patient A in both ways of treatment, given by the group model.

5. Discussion and Conclusion

This multimethodology was applied to acute cholecystitis cases due to the lack of information detected, however, it can be adapted to other diseases providing information on how surgeons think alone and preparing them with the type of questions for a more dynamic decision conference culminating in the development of a model to assist them.

The involvement of surgeons in all the steps lead to more acceptance and participation in the decision conference. The use of MACBETH approach was also valorised for asking for qualitative information instead of quantitative.

Nevertheless, the major limitation is the patient cases built, because being very general does not allow more precise answers in the model. Additionally, in the individual models, the inconsistencies were not solved with the surgeons leading to values that can differ from their opinion.

The objectives were reached, the variability between surgeons' opinions was explored, it was not found influence on a final decision for a patient for the observed patient cases even with some different opinions on the judgments, and the decision support model was built.

As a future work, there is a need to develop more specified patient cases and to improve the web-based platform, allowing the detection of inconsistencies and the validation of the steps.

6. References

[1] R. Flin, G. Youngson, and S. Yule, "How do surgeons make intraoperative decisions?," *Qual. Saf. Health Care*, vol. 16, pp. 235–239, 2007

[2] P. J. Kennedy, C. M. Leathley, and C. F. Hughes, "Clinical practice variation," *Med. J. Aust.*, vol. 193, no. 8, pp. 97–99, 2010.

[3] J. D. Birkmeyer, S. M. Sharp, S. R. Finlayson, E. S. Fisher, and J. E. Wennberg, "Variation profiles of common surgical procedures.," *Surgery*, vol. 124, pp. 917–923, 1998.

[4] J. D. Birkmeyer, B. N. Reames, P. McCulloch, A. J. Carr, W. B. Campbell, and J. E. Wennberg, "Understanding of regional variation in the use of surgery," *Lancet*, vol. 382, no. 9898, pp. 1121–1129, 2013.

[5] K. Pauley, R. Flin, S. Yule, and G. Youngson, "Surgeons' intraoperative decision making and risk management," *Am. J. Surg.*, vol. 202, no. 4, pp. 375–381, 2011.

[6] M. Zhou, X. Gu, J. Xiang, and Z. Chen, "Comparison of Clinical Safety and Outcomes of Early versus Delayed Laparoscopic Cholecystectomy for Acute Cholecystitis : A Meta-Analysis," *Sci. World J.*, vol. 2014, pp. 1–8, 2014.

[7] V. Halpin, "Acute cholecystitis," *Clin. Evid. (Online).*, pp. 1–24, 2014.

[8] M. G. Gu, T. N. Kim, J. Song, Y. J. Nam, J. Y. Lee, and J. S. Park, "Risk Factors and Therapeutic Outcomes of Acute Acalculous Cholecystitis," *Digestion*, vol. 90, no. 2, pp. 75–80, 2014.

[9] "Acute cholecystitis: MedlinePlus Medical Encyclopedia." [Online]. Available: https://www.nlm.nih.gov/medlineplus/ency/article/000264.htm. [Accessed: 21-Oct-2015].

[10] G. Adunlin, V. Diaby, and H. Xiao, "Application of multicriteria decision analysis in health care: a systematic review and bibliometric analysis," *Heal. Expect.*, p. n/a–n/a, 2014.

[11] C. a. Bana e Costa and J. C. Vansnick, "A critical analysis of the eigenvalue method used to derive priorities in AHP," *Eur. J. Oper. Res.*, vol. 187, no. 3, pp. 1422–1428, 2008.

[12] C. a. Bana e Costa, J.-M. De Corte, and J.-C. Vansnick, "Macbeth," *Work. Pap. LSEOR*, pp. 1–40, 2003.

[13] C. a. Bana E Costa, M. C. Carnero, and M. D. Oliveira, "A multi-criteria model for auditing a Predictive Maintenance Programme," *Eur. J. Oper. Res.*, vol. 217, no. 2, pp. 381–393, 2012.

[14] M. D. Oliveira, T. C. Rodrigues, C. A. Bana e Costa, and A. B. De Sá, "Prioritizing health care interventions: A multicriteria resource allocation model to inform the choice of community care programmes," in *Advanced Decision Making Methods Applied to Health Care*, vol. 173, E. Tànfani and A. Testi, Eds. Milano: Springer Milan, 2012, pp. 141–154.

[15] D. F. Lopes, M. D. Oliveira, and C. a Bana e Costa, "Occupational health and safety: Designing and building with MACBETH a value risk-matrix for evaluating health and safety risks," *J. Phys. Conf. Ser.*, vol. 616, p. 012010, 2015.

[16] T. Cardoso, M. D. Oliveira, A. Barbosa-Póvoa, and S. Nickel, "Moving towards an equitable long-term care network: A multi-objective and multi-period planning approach," *Omega*, vol. 58, pp. 69–85, 2016.

[17] P. Pinheiro, A. Castro, and M. Pinheiro, "A Multicriteria Model Applied in the Diagnosis of Alzheimer's Disease: A Bayesian Network.," *11th IEEE Int. Conf. Comput. Sci. Eng.*, pp. 15–22, 2008.

[18] L. D. Phillips and C. a. Bana E Costa, "Transparent prioritisation, budgeting and resource allocation with multi-criteria decision analysis and decision conferencing," *Ann. Oper. Res.*, vol. 154, no. 1, pp. 51–68, 2007.

[19] C. A. Bana e Costa, J.-M. De Corte, J.-C. Vansnick, J. C. B. Costa, M. P. Chagas, É. C. Corrêa, I. M. João, F. M. Lopes, J. C. Lourenço, and R. Sánchez-López, "M-MACBETH Version 2.4.0 User's Guide," 2005.

[20] C. A. Bana e Costa, J. A. A. Ferreira, and É. C. Corrêa, "Metodologia Multicritério de Apoio à Avaliação de Propostas em Concursos Públicos," *Casos de Aplicação da Investigação Operacional, C.H. Antunes, L.V. Tavares (eds.), McGraw-Hill*, Lisbon, pp. 336–363, 2000.

[21] "Clavien-Dindo Classification." [Online]. Available: http://www.surgicalcomplication.info/index-2.html. [Accessed: 31-Aug-2015].

[22] R. Gelbard, E. Karamanos, P. G. Teixeira, E. Beale, P. Talving, K. Inaba, and D. Demetriades, "Effect of delaying same-admission cholecystectomy on outcomes in patients with diabetes.," *Br. J. Surg.*, vol. 101, no. 2, pp. 74–8, 2014.